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TAMPER RESISTANT CARBURETOR MIXTURE NEEDLES

Technical Field of the Invention

1 This invention relates to carburetors and, more
2 particularly, to a tamper resistant mixture adjustment
3 screw arrangement for a carburetor.

4

5 Background of the Invention

6 Environmental protection statutes and regulations
7 are beginning to place limits on the combustion products
8 of small power tools, such as gasoline powered lawn
9 mowers, edgers, chain saws, and line trimmers. Such
10 powered tools usually employ a diaphragm carburetor to
11 control the air/fuel mixture fed to the two-cycle
12 gasoline engine. Fuel is fed to an engine intake path by
13 a fuel pump. The fuel pressure is regulated at a fixed
14 pressure by a fuel pressure regulator. The fuel pressure
15 regulator is equipped with a fuel chamber that stores
16 fuel sent from the fuel pump. A diaphragm that forms one
17 of the fuel chamber walls and a control valve that is
18 interlocked to the motion of the diaphragm opens and
19 closes the fuel chamber inlet. Thus, in any position,
20 fuel is properly supplied to the engine. Fuel travels to
21 the intake path from the fuel chamber through either a
22 main fuel path or an idle fuel path.

1 A manual fuel mixture adjustment screw is provided
2 for independently controlling the effective areas of the
3 main and idle fuel paths. The adjustment screw includes
4 a needle-shaped valve that can be advanced into or
5 withdrawn from the fuel path.

6 The carburetor mixture adjustment screws are semi-
7 fixed positionally to limit the amount of adjustment the
8 operator can achieve for exhaust emissions requirements.
9 The carburetor mixture needles can still be adjusted but
10 the angular range is limited, usually by a cap or similar
11 design preventing full rotational movement. Such an
12 arrangement is disclosed and described in U.S. Patent
13 No. 5,603,869.

14 During the manufacturing of the end product the
15 carburetor is adjusted to achieve peak performance and
16 obtain acceptable exhaust emissions output. The 2-cycle
17 engine is tested and the carburetor mixture needles are
18 adjusted by the manufacturer to obtain a specific
19 performance specification during the assembly process.
20 After these performance objectives are achieved, the
21 adjustor installs the limiter caps onto the mixture
22 needles. Frequently, during the installation process of
23 the limiter caps, the carburetor adjustment changes.
24 When this occurs the final set point of the carburetor
25 can either be unacceptable for performance or for exhaust
26 emission standards.

1 Carburetor mixture needles on 2-cycle hand held
2 products are very sensitive because the needle tip and
3 jet diameters are very small. This is because the engine
4 displacement size is small compared to those of larger
5 engines used on automobiles, motorcycles, and the like.
6 With the small engine displacement the fuel requirements
7 is proportionally smaller which is what determines the
8 effective jet size.

9 Depending on the 2-cycle engine design and the end
10 product application, the carburetor can be equipped with
11 either 2 mixture needles or a single mixture needle.
12 With the two-mixture needle design both a low speed
13 (idle) and a high speed (wide open throttle) fuel
14 richness can be adjusted. On a single mixture needle
15 design, only the high-speed mixture can be adjusted.
16 This is acceptable on products that do not require strict
17 performance at a low speed and can tolerate a fixed fuel
18 flow rate.

19 The problem of carburetor adjustment changing when
20 the limiter caps are installed are caused by several
21 environmental factors. One factor is the amount of
22 physical pressure required to install the cap onto the
23 mixture needle. Several limiter cap designs rely on an
24 interference fit between the mixture needle and the
25 limiter cap to retain the cap on the needle. The force

1 required to press the cap on the needle often moves the
2 needle, and can even bend the needle.

3 Another factor that can affect the mixture needle is
4 side pressure which tends to load the needle off center.
5 The side load is created by the limiter cap design.

6 Several carburetor designs rely on two mixture needles
7 with close proximity to each other. On the two needle
8 carburetor designs, the limiter caps have physical stops
9 that are designed to contact the other mixture needle
10 cap. This close proximity and tight design clearances of
11 the two limiter caps can create a side load that will
12 physically move the needles off their natural center to
13 change the flow rate through the jet.

14 Further, another factor is the surrounding
15 construction. Products like chain saws have housings and
16 grommets designed with close proximity to the carburetor
17 mixture needles. Grommets are used to keep dirt and
18 debris out of the carburetor housing, which can cause
19 damage to the product. These grommets can also apply a
20 side load to the needles causing them the skew from their
21 natural center.

22 Still further, another factor that can affect the
23 mixture needle is vibration caused by the 2-cycle engine.
24 This vibration creates a resonate vibration on the needle
25 and will change the flow characteristics of the needle
26 tip and jet nozzle. The length of the needle and

1 additional mass of the limiter caps increases the
2 vibration affect to the flow.

3 Another problem with the limiter cap application on
4 carburetor mixture needles is the span of adjustment
5 available. Government regulations has mandated that the
6 limits of adjustment must be inspected and fall within
7 the required emissions limits. The consistent reduction
8 in allowable exhaust emissions has forced manufacturers
9 to decrease the amount of allowable consumer adjustment
10 to a point where any adjustment is impractical and
11 provides no real benefit to the consumer.

12 These tight government regulations have also caused
13 problems with the manufacturing of these products and the
14 adjustment parameters are so stringent that the
15 carburetor adjustment has become critical to the assembly
16 operation. The strict adjustment specification sometimes
17 requires several installations of limiter caps on one
18 product before an acceptable set point is achieved, and
19 the product is allowed to be shipped. This assembly
20 bottleneck is a major cost factor in end product in terms
21 of labor hours to build the final product.

22 A need exists for an arrangement which permits the
23 carburetor mixture needles to be adjusted by the
24 manufacturer or an authorized dealer to position the
25 needle valve or valves at a position to obtain a specific
26 performance specification during the assembly process or

1 during reconditioning by the dealer, but prevents
2 adjustment by the consumer.

3

4 Brief Description of the Invention

5 According to the invention, the carburetor mixture
6 needles are designed so that the limiter cap can be
7 omitted from the final design. This is achieved by a
8 carburetor mixture needle design that cannot be turned by
9 common hand tools, and is tamper resistant. The
10 carburetor mixture adjustment performed by the
11 manufacturer is considered fixed and non-adjustable by
12 the consumer. This is not seen to be a problem since the
13 strict emissions regulations has forced the manufacturers
14 into carburetor designs that did not allow for any
15 reasonable adjustment and therefore the consumer has no
16 ability to correct the mixture setting.

17 The new tamper resistant mixture needle design
18 according to this invention has a needle valve head that
19 can be turned only with a special tool accessible by the
20 manufacturer and authorized service dealers to perform
21 carburetor adjustments. The mixture needle heads
22 preferably have a special straight knurl pattern on the
23 outside diameter of the head of the mixture needle that
24 allows a special screwdriver tool to engage and turn the
25 mixture needles for factory adjustment. The straight
26 knurl design can be formed in different shapes and

1 achieve the same affect. Another style would be splined
2 or gear-like teeth.

3 There is no common tool commercially available for
4 this style fastener or hardware. The tool according to
5 this invention has an end formed with a mating profile
6 that engages the straight knurl shape on the mixture
7 needle heads. The teeth-like protrusions on the tool are
8 staggered to ensure easy alignment. The number of teeth
9 in the tool may be varied as long as they correspond with
10 the mixture needle knurl spacing.

11 The advantage of the tamper resistant needle design
12 is the stability of the adjustment achieved with this
13 style mixture needle. The problems seen with the prior
14 art design with respect to side loading, vibration, and
15 changes after the limiter caps were installed are all
16 minimized. This is mainly because no external forces are
17 acting upon the mixture needles, and the needles do not
18 have additional mass attached to the end of them.

19 Another advantage of this style needle design is in
20 the form of assembly labor. The time to adjust the
21 carburetor properly is reduced because of the mixture
22 stability, and the setting does not require re-adjustment
23 because the limiter cap installation may have changed the
24 performance outside the acceptable parameters. The time
25 to install the limiter caps on the mixture needles is
26 also eliminated from the assembly operation.

1 There are also advantages from the emission
2 regulations standpoint. Government emissions
3 requirements are audited and monitored by the
4 manufacturer for compliance. The time spent testing and
5 auditing product is reduced because the non-adjustable
6 style mixture needles. There is only one position (as-
7 set) and no limits, such as on limiter cap style, which
8 still have some range of movement allowed.

9 In order to achieve the tamper resistant requirement
10 as outlined by the two government agencies, California
11 Air Resources Board (CARB), and Environmental Protection
12 Agency (EPA), described above, the manufacturer has to
13 prove that the design is tamper resistant. The needle
14 head design is not enough if the consumer can still
15 access and turn the mixture needles with, for example,
16 pliers. So to prohibit use of other means of adjustment,
17 the surrounding construction is designed to limit access
18 to the mixture needles.

19 On gas chain saws a carburetor grommet can be used
20 to prevent access to the mixture needles. The grommet
21 has a small access hole that allows the adjustment tool
22 to reach the needles for adjustment but is sized to
23 prevent needle adjustment by other means. The grommet is
24 designed so it cannot be removed from the chain saw
25 without major disassembly of the product by means of a

1 protruding wall that prevent removal from the mixture needles.

2 On string trimmers, leaf blowers, hedge trimmers and
3 the like, the carburetor location may be more accessible
4 than that on a chain saw, so the carburetor casting is
5 provided with an additional protrusion that shields the
6 mixture needles from being assessed and turned. This
7 protrusion may be integral to the carburetor body
8 casting, and therefore cannot be removed without
9 permanent damage to the carburetor. Other means of
10 construction are possible to achieve the same function as
11 the integral wall. For example, a separate stamped steel
12 cup formed in the same shape as the wall can be attached
13 to the carburetor body.

14 According to one aspect of this invention, a
15 blocking curb extends from the carburetor body to a level
16 which at least substantially corresponds to a projecting
17 extent of each adjustment screw. The blocking curb is
18 closely spaced to the head of the adjusting screw to
19 prevent the screw from being turned by commonly available
20 tools, but to permit the screw to be adjusted by a
21 special adjusting tool.

22 According to one aspect of the invention the
23 blocking curb comprises a series of posts molded into the
24 carburetor body. According to another aspect of the
25 invention the blocking curb is integral with the
26 carburetor body, surrounds the adjustment screw or

screws, and has an inside arcuate surface which is closely spaced to each head for at least a major portion of the side surface of each head. According to a further aspect of the invention, the blocking curb comprises a drawn sleeve which surrounds the adjustment screw or screws and is captured by the adjustment screw spring.

According to a still further aspect of this invention, the blocking curb is a grommet which extends from the carburetor body and forms a chamber surrounding each adjusting screw head. A cylindrical access opening is provided for each screw head and each access opening is axially aligned with a screw head. The diameter of each opening is slightly larger than the diameter of each axially aligned screw head to prevent the screw from being turned by commonly available tools, but to permit the screw to be adjusted by a special adjusting tool adapted to engage a sidewall of the screw head.

Brief Description of the Drawings

Fig. 1 is a perspective view of the carburetor having a tamper resistant screw arrangement according to one aspect of this invention;

Fig. 2 is an elevational view of the arrangement shown in Fig. 1;

Fig. 3 is a cross-sectional view, the plane of the section being indicated by the line 3-3 in Fig. 2;

1 Fig. 3B is a cross-sectional view, similar to
2 Fig. 3, but showing a screw having a top surface
3 according to a further aspect of the invention;

4 Fig. 4 is an adjusting tool for tamper resistant
5 screws;

6 Fig. 5 is an end view of the adjusting tool shown
7 in Fig. 4;

8 Fig. 5A is an end view of an adjusting tool
9 according to a further aspect of this invention;

10 Fig. 5B is a top view of a screw head adapted to be
11 engaged by the adjusting tool of Fig. 5A;

12 Fig. 5C is an end view of an adjusting tool
13 according to a further aspect of this invention;

14 Fig. 5D is a top view of a screw head adapted to be
15 engaged by the adjusting tool of Fig. 5C;

16 Fig. 6 is a fragmentary sectional view of a
17 carburetor having a tamper resistant screw arrangement
18 according to a further aspect of this invention;

19 Fig. 6A is a fragmentary elevational view of the
20 carburetor shown in Fig. 6, the plane of the view being
21 indicated by the line 6A-6A in Fig. 6;

22 Fig. 7 is a fragmentary elevational view of a
23 carburetor having a tamper resistant screw arrangement
24 according to a further aspect of this invention;

1 Fig. 8 is an elevational view of a carburetor having
2 a tamper resistant screw arrangement according to a still
3 further aspect of this invention;

4 Fig. 9 is an end view of the carburetor shown in
5 Fig. 8, the plane of the view being indicated by the
6 line 9-9 in Fig. 8; and

7 Fig. 10 is a fragmentary cross sectional view, the
8 plane of the section being indicated by the line 9-9
9 in Fig. 9.

10

11 Detailed Description of the Invention

12 Referring now to the drawings and, particularly, to
13 Figs. 1-5D, there is illustrated an engine carburetor 20
14 having a carburetor body 22. Typically the carburetor 20
15 is used on a two-cycle small engine. Depending on the
16 two-cycle engine design and the end product application,
17 the carburetor can be equipped with either two mixture
18 adjustment screws or needles or a single mixture
19 adjustment screw or needle. With the two mixture needle
20 design, both a low speed (idle) and a high speed (wide
21 open throttle) fuel richness can be adjusted. On a
22 single mixture needle design, only the high-speed mixture
23 can be adjusted. This is acceptable on products that do
24 not require strict performance at low speed and can
25 tolerate a fixed flow rate.

1 In the illustrated embodiment the carburetor 20 has
2 a low speed adjustment screw 24 and a high speed
3 adjustment screw 26. Each screw 24 and 26 has a threaded
4 shank 28 and a head portion 30. The head portion 30 is
5 defined by a smooth top surface 32 and an undulant,
6 uneven surface 34. The phrase "undulant, uneven surface"
7 is intended to include a straight knurl shape 35, shown
8 in Figs. 2 and 3, a sinusoidal pattern 35b, shown in
9 Fig. 5B, and a gear tooth or cog pattern 35d, shown in
10 Fig. 5D. To prevent the adjustment screws 24 and 26 from
11 being rotated due to vibration of the operating engine on
12 which the carburetor is utilized, a compression spring 36
13 is received over the shanks of the screws and bears on
14 the head portion 30 and the carburetor body 22. The
15 phase "smooth top surface" is intended to include
16 surfaces of revolution generated by rotating a straight,
17 irregular, or curved line intersecting the longitudinal
18 axis of the adjustment screw about the longitudinal axis.
19 Such surfaces are characterized by the absence of tool
20 engaging features such as a slot for engagement by a
21 screw driver. An example of a smooth top surface is a
22 surface of revolution generated by an irregular line 32a
23 rotated about an axis and is a truncated pyramid 32b
24 shown in Fig. 3B.

1 A blocking curb 38 extends from the body 22 of the
2 carburetor 20 to a level which at least substantially
3 corresponds to the projecting extent of the top of each
4 head portion 30. In the embodiment illustrated in
5 Figs. 1-5D, the blocking curb 38 is molded as a part of
6 the body 22 and, as may be seen most clearly in Fig. 3,
7 extends beyond the top of each head portion 30. An
8 internal wall 40 of the blocking curb 38 is closely
9 spaced to the head portion 30 of each screw to prevent
10 the head portion from being turned by commonly available
11 tools, such as needle-nose pliers. It should be noted
12 that the smooth top surface 32 of the head prevents the
13 head from being turned by a screw driver.

14 A special adjusting tool 42 is provided having an
15 end socket 44. An inside surface 46 of the socket 44 has
16 an undulant, uneven surface which, in Fig. 5, is a
17 straight knurl surface 48. The surface 48 is adapted to
18 fit over and conform to the straight knurl shape 35 of
19 the head portion 30 as shown in Figs. 2 and 3. The end
20 socket 44 has an outside diameter which is dimensioned to
21 fit within the internal wall 40 of the blocking curb 38.

22 According to another aspect of this invention, and
23 as is illustrated in Fig. 5A, an inside surface of a
24 socket 44a has an undulant, uneven surface, which is a
25 sinusoidal surface 48a. The surface 48a is adapted to

1 fit over and conform to a sinusoidal shape 35b of a head
2 portion 30b, as shown in Fig. 5B.

3 According to a further aspect of this invention, and
4 as is illustrated in Fig. 5C, an inside surface of a
5 socket 44c has a gear tooth or cog pattern 46c. The
6 pattern 46c is adapted to fit over and conform to a gear
7 or cog shape 35d of a head portion 30d, as is shown
8 in Fig. 5D.

9 Referring now to Figs. 6 and 6A, a blocking curb 50,
10 according to a further aspect of this invention, is
11 illustrated. The blocking curb 50 comprises a drawn
12 sleeve 52 which surrounds the adjustment screws 24 and 26
13 and is captured by the adjustment screw springs 36. An
14 internal wall 54 of the blocking curb is closely spaced
15 to the head portion 30 of each screw to prevent the head
16 portion from being turned by commonly available tools,
17 such as needle-nosed pliers. The end socket 44 of the
18 adjusting tool 42 is dimensioned to fit within the
19 internal wall 54 of the blocking curb 50.

20 According to a further aspect of this invention, and
21 as is illustrated in Fig. 7, a blocking curb 60 comprises
22 a series of posts 62. The posts 62 are molded as part of
23 the body 22 and extend beyond the top of each head
24 portion 30. Each post 62 is closely spaced to the head
25 portion 30 of each screw to prevent the head portion from

1 being turned by commonly available tools, such as
2 needle-nosed pliers. The end socket 44 of the adjusting
3 tool 42 is dimensioned to fit within the space between
4 each post 62 and the head portion 30 of each screw.

5 According to a still further aspect of the
6 invention, and as is illustrated in Figs. 8-10, a
7 blocking curb 70 comprises a grommet 72. The grommet 72
8 is particularly useful on gasoline powered chain saws
9 since it cannot be removed from the chain saw without
10 major disassembly, as will become apparent. The
11 grommet 72 may be molded from a hard plastic and
12 comprises a body 74 having a passageway 76 which
13 receives and provides access to a carburetor idle speed
14 stop screw 78 and a pocket 80 which receives a blade
15 extension 82 of a diaphragm cover plate 84. This
16 mounting arrangement correctly positions the grommet 72
17 for mounting on a carburetor body 84. The grommet 72
18 includes a chamber 86 which surrounds mixture adjusting
19 screws 88 and 90. Cylindrical access openings 92 and 94
20 lead to the chamber 86 and each access opening 92 and 94
21 is axially aligned with an adjusting screw head. The
22 diameter of each opening 92 and 94 is slightly larger
23 than the diameter of each axially aligned screw head to
24 prevent the screw from being turned by commonly available

1 tools, but to permit the screw to be adjusted by the
2 adjusting tool 42 in the previously described manner.

3 The grommet 70 cannot be easily removed from the
4 carburetor 84 since it is retained by an engine shroud
5 wall 96.

6 While the invention has been shown and described
7 with respect to particular embodiments thereof, those
8 embodiments are for the purpose of illustration rather
9 than limitation, and other variations and modifications
10 of the specific embodiments herein described will be
11 apparent to those skilled in the art, all within the
12 intended spirit and scope of the invention. Accordingly,
13 the invention is not to be limited in scope and effect to
14 the specific embodiments herein described, nor in any
15 other way that is inconsistent with the extent to
16 which the progress in the art has been advanced by
17 the invention.